

5 Thrust

Forces of Flight

Four forces push and pull an airplane in flight. The force of **gravity** pulls the airplane downward. The airplane's wings produce an upward force called **lift** that counteracts gravity. A force called **drag**, caused by air resistance, slows the airplane down. To fight drag, the airplane uses a propeller or jet engine to produce a forward force called **thrust**.

The Basics

Thrust is the force of flight that opposes drag. The push or pull of an airplane's engines propels it forward, generating lift and the ability to fly.

Without thrust, airplanes are just gliders, which can fly only under certain conditions and are not practical for transportation. The Wright Brothers made the first successful powered flight in 1903 in an airplane with two "pusher" propellers. The advent of powered flight made human air travel possible.

There are four main types of systems for producing thrust in modern aircraft: propellers, jet turbine engines, ramjet engines, and rocket engines. Each produces thrust in a different way.

An airplane may be powered by a single propeller, as on the P-51 Mustang, or several.



Propeller

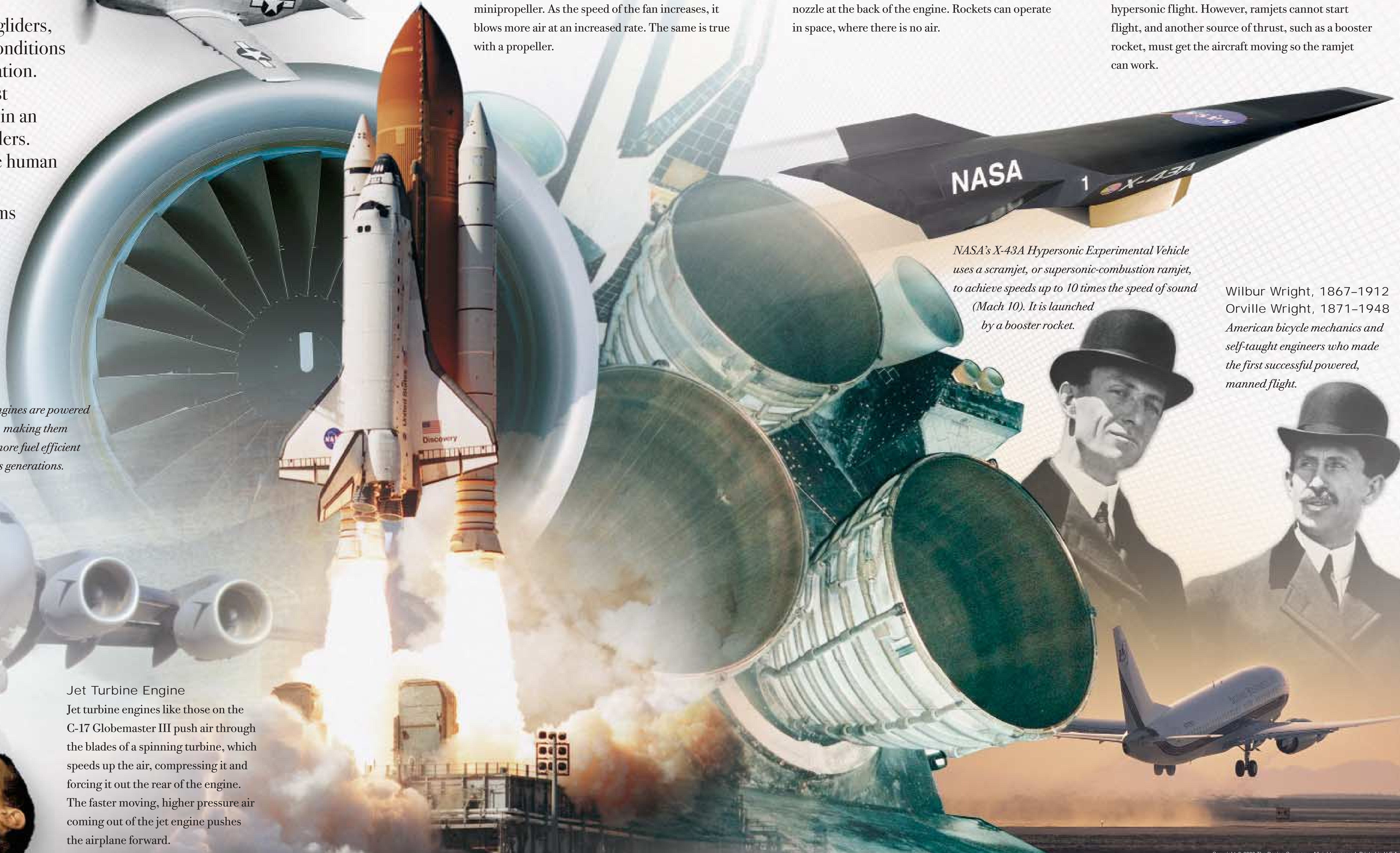
Propellers are actually airfoils. When they spin, propellers create forward or reverse thrust, depending on which way the blades are angled. A common household fan is an example of a minipropeller. As the speed of the fan increases, it blows more air at an increased rate. The same is true with a propeller.

Rocket Engine

The rocket engine is different from the other three engines in that it does not require the presence of outside air to operate. Rockets burn liquid or solid fuels to create thrust, pushing hot exhaust out a nozzle at the back of the engine. Rockets can operate in space, where there is no air.

Ramjet Engine

The ramjet is a variation on the jet turbine engine in which the engine has no moving parts. Because a ramjet has no moving parts, it is much lighter than a jet turbine engine, and it is ideal for supersonic and hypersonic flight. However, ramjets cannot start flight, and another source of thrust, such as a booster rocket, must get the aircraft moving so the ramjet can work.



NASA's X-43A Hypersonic Experimental Vehicle uses a scramjet, or supersonic-combustion ramjet, to achieve speeds up to 10 times the speed of sound (Mach 10). It is launched by a booster rocket.

*Wilbur Wright, 1867–1912
Orville Wright, 1871–1948
American bicycle mechanics and self-taught engineers who made the first successful powered, manned flight.*

Today's jet engines are powered by turbofans, making them quieter and more fuel efficient than previous generations.

Jet Turbine Engine

Jet turbine engines like those on the C-17 Globemaster III push air through the blades of a spinning turbine, which speeds up the air, compressing it and forcing it out the rear of the engine. The faster moving, higher pressure air coming out of the jet engine pushes the airplane forward.

